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ORSA: Prospective Solvency Assessment and Capital Projection Modelling

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Overview

Fundamental to the ORSA is the ability to understand how regulatory and economic capital requirements will behave under different feasible future business and financial circumstances. This creates the need for a modelling capability that meets two key requirements: the ability to determine appropriate multi-year scenarios (deterministic stress tests or stochastic) in which to project the insurer's business; and the ability to accurately assess the capital requirements that would be created within these scenarios. This report gives an overview of these modelling challenges and some potential solutions.

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1. Introduction

Own Risk and Solvency Assessment (ORSA) has emerged as the global framework for internal assessment of insurance firms' current and prospective risk exposures and capital resources. It is the key element of the European Union's Solvency II Pillar II, and in the US the NAIC has mandated that US insurers must have an ORSA in place by 1st January 2015[1].

ORSA is generally not intended to be a prescriptive regulatory calculation but instead asks firms to describe how they manage risk and capital across the enterprise. Many insurance firms have identified a range of quantitative modelling capabilities that they will need in order to support the objectives of the ORSA. These might include:

» Real-time monitoring of current regulatory capital requirements.

» The firm's own assessment of the economic capital requirements of the business. This could be calculated under a definition of capital that is specific to the business and hence different from regulatory capital requirements such as Solvency II's Pillar I's 1-year 99.5% VaR capital or the CTE 90 run-off capital used in the US principle-based approaches to reserving and capital (which we will refer to as US PBA in this paper).

» A capability to make a multi-year projection of the insurer's business plan under a range of different financial and business scenarios, with an assessment of the solvency requirements generated in those scenarios.

This paper will focus on the quantitative modelling approaches that can be developed to meet the latter of these requirements: i.e. to make a multi-year capital projection under a range of scenarios. We believe both US firms undertaking NAIC ORSA and European firms undertaking SII ORSA will seek to develop this capability, and the modelling challenges arising in both cases will be fundamentally similar.

It is also interesting to note that banks in both the US and the European Union have recently been required to develop multi-period stress testing and capital projection capabilities to meet various regulatory requirements of the US Federal Reserve and the European Banking Authority. It may be useful to consider what can be learned from the methodologies developed by banks in their analogous risk assessment activities.

[1] See NAIC's Risk Management and Own Risk and Solvency Assessment Model Act (September 2012) and NAIC ORSA Guidance Manual (November 2011). The Office of the Superintendent of Financial Institutions Canada has also recently released a document proposing the adoption of an ORSA framework, see OSFI's Life Insurance Regulatory Framework (September 2012).

2. What are insurers trying to measure in the ORSA?

Insurers use the capital provided by shareholders to take on and then manage various types of risk in order to provide a return on that capital. Understanding how these risks, the capital required to support them and the return on that capital evolve over time in different scenarios and how management actions would mitigate against these changing risks is an integral part of insurers' risk management. It is also a fundamental element of any ORSA process.

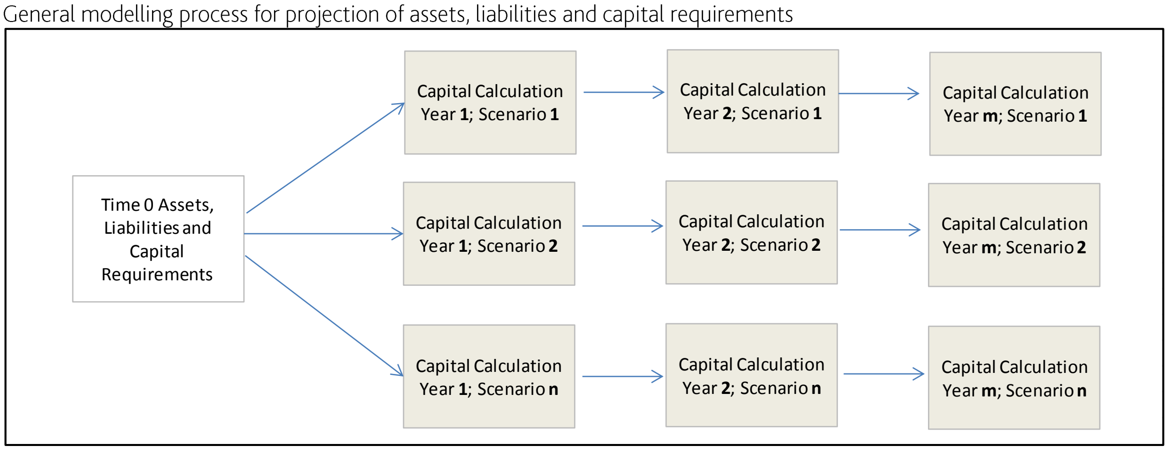
The ORSA process needs to have a quantitative foundation that is consistent with the insurer's other business metrics and regulatory capital processes. There is little point in developing processes and modelling for ORSA which for example do not reflect the reality of the regulatory solvency position for the insurer.NGiven the very general nature of the ORSA and the many different regulatory systems there is a wide range of potential business and risk metrics that an ORSA will have to produce. However, the core of this process should be to understand how the capital requirements (regulatory, ratings, economic) of the business progress over time across a range of scenarios.

The modelling challenge of this multi-year capital projection requirement is the focus of this paper. Both in Europe and in North America, current regulatory and economic capital requirements are often assessed using stochastic simulation approaches. Whether the capital requirement is defined using a 1-year market-consistent Value-at-Risk approach or a CTE run-off approach, a similar technical challenge arises – a huge number of stochastic simulations will, in theory, be needed if the capital requirements are to be measured not just in current conditions, but at several time steps in each of a number of multi-year projections.

The diagram below describes the general approach that we will adopt in this paper to this modelling problem.

Exhibit 1

General modelling process for projection of assets, liabilities and capital requirements



This general projection process can be distilled into three distinct modelling stages:

» Determine the multi-year scenarios in which the business is to be projected. These could be a handful of deterministic scenarios or thousands of stochastic scenarios. In both cases, the scenario model is typically done at a 'macro' level.

» Describe how all of the significant risk exposures of the insurer's balance sheet behave in each of these macro scenarios.

» Calculate the business metrics of interest within each of the stress tests, e.g. regulatory capital. Note that for n m-year scenarios, the capital calculation would need to be implemented $n \times m$ times.

These stages can capture the high-level modelling process that is applicable to any multi-year projection process, whether using a stochastic or deterministic modelling approach. We now discuss each of these stages in turn with particular focus on the implementation challenges and methodology choices that will arise for insurance groups in the context of ORSA.

3. Generating multi-year macro stress scenarios

The non-prescriptive nature of ORSA presents firms with some fundamental modelling choices when considering which multi-year scenarios to use to project their business. In particular, do they wish to use thousands of stochastic scenarios or a handful of deterministic scenarios? In general, regulators are likely to permit either approach. For example, the NAIC's Guidance Manual Section III states:

> *Methods for determining the impact of future financial position may include simple stress tests or more complex stochastic analyses.*

The stochastic approach will allow firms to examine the robustness of their business across a very wide range of future possible economic outcomes. It also provides probabilistic measures of the likelihood of different types of scenario arising. However, there may be very significant computational challenges to assessing the future capital levels associated with thousands of different scenario paths, especially when the business includes liabilities with complex embedded options. Some might argue that the use of a handful of deterministic scenarios is also more useful when using the ORSA process to explain what management decisions would be applied over the course of the projection. That is, senior management can discuss and document its intended actions over a handful of different adverse scenarios, but cannot realistically undertake that exercise for thousands of scenarios.

For the above reasons, it is likely that most firms will, at least initially, use deterministic, rather than stochastic, scenarios in the projection of their business for ORSA purposes. We expect this to apply both to Solvency II firms and for firms complying with NAIC requirements in the US.

So, how are these deterministic scenarios derived? In particular, should they be of a particular 'strength' of adversity? And how do firms ensure that the scenarios that are selected are effective in identifying the material medium-term risks inherent to its business profile and plans? Again, the NAIC Guidance Manual makes it clear that the firm's own specific set of risk exposures should drive the identification of relevant stress tests: Section III states that:

> *Because the risk profile of each insurer is unique, US insurance regulators do not believe there is a standard set of stress conditions that each insurer should run.*

Most insurance groups are diverse and complex businesses that may be exposed to many forms of risk. It is likely that the firm will need to consider many different stress scenarios in the process of assessing its medium-term robustness. It may also consider different forms of scenario:

- 'Top-down' macro-economic scenarios that capture their systematic exposures to adverse economic and financial market outcomes (almost all insurance firms are exposed to varying degrees to falls in equity markets and in interest rates, and increases in credit spreads and in option-implied volatility).
- Systematic insurance risk scenarios (unexpected increases in longevity; behavior of underwriting cycle; pandemics; etc).
- 'Bottom-up' scenarios that reflect firm-specific risk exposures arising from their unique strategic and / or operational profile (unexpected legal liabilities, operational failures, etc).
- And finally, it may be useful to consider combinations of these scenarios in order to understand how interactions between these risk exposures can cause compounded losses. For example, what would the economic and financial market consequences be of a major pandemic?

The top-down macro-economic scenarios are perhaps easiest to envisage. These will likely be thematic scenarios such as a global depression; war in the Middle East; disorganised Euro sovereign debt default, and so on. Typically, the modelling of such scenarios would first involve some expert economic judgement on the impact that these scenarios would have on macro-economic factors (inflation, GDP growth, corporate profit margins, etc.), and then econometric models may be used to estimate how unexpected shocks to those macro-economic variables could impact on high-level financial market behavior such as equity returns, yield curves, etc.

As an example of how these macro stresses might be established, Moody's economic experts regularly publish economic forecasts for a wide range of both global and regional economic variables under a range of alternative macro-economic scenarios. In 2012, these were[2]:

- Scenario 1: Stronger Near-Term Rebound
- Scenario 2: Slower Near-Term Growth

[2] See, for example, "*U.S. Macroeconomic Outlook: Alternative Scenarios", Moody's Analytics, April 2012*.

» Scenario 3: Double-Dip Recession

» Scenario 4: Protracted Slump

» Scenario 5: Below-Trend Long-Term Growth

» Scenario 6: Oil Price Increase, Dollar Crash Inflation

In each of these scenarios, 5-year paths for a range of financial market and economic variables are specified, together with an estimate of the probabilistic severity of the scenario and an intuitive description of the background circumstances that determine the scenario outcome. For example, Scenarios 4 and 5 are both intended to represent cases where there is a 96% probability that the economy will perform better. But the two scenarios differ in terms of the circumstances that drive the poor economic outcomes and how these impact on the behavior of financial market and economic variables.

Based on its own understanding of its risk exposures and risk management strategies, a firm may be able to identify by inspection which of these scenarios it is more susceptible to, and decide to project its business under the most testing scenario. Alternatively, it may decide to project its business under several of these types of scenarios in order to explore the robustness of their risk and capital plans under a wide range of circumstances. Exhibits 2 and 3 summarise the 5-year paths projected for key financial market and economic variables under Scenarios 4 and 5 respectively.

Exhibit 2

5-year paths for key financial market and economic variables in Scenario 4

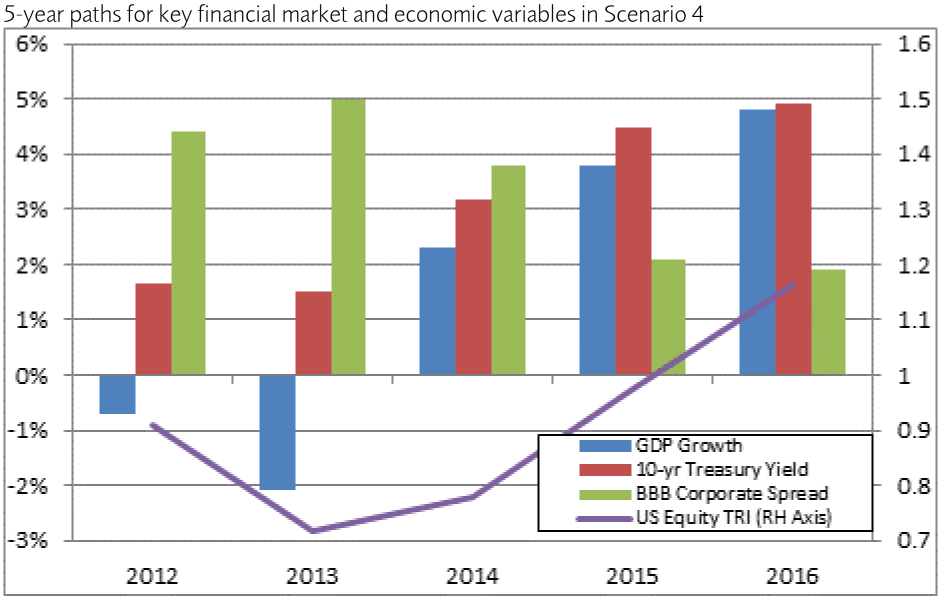
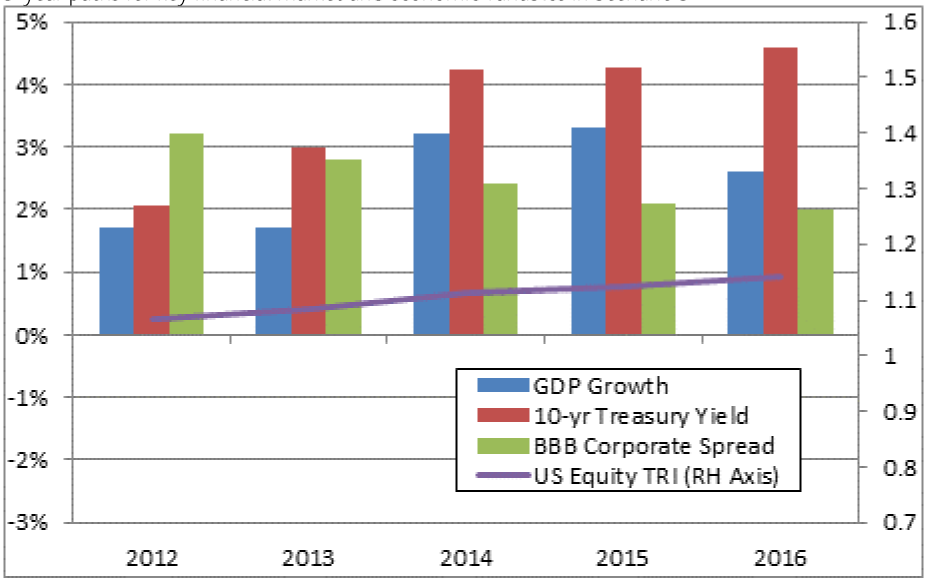


Exhibit 3

5-year paths for key financial market and economic variables in Scenario 5

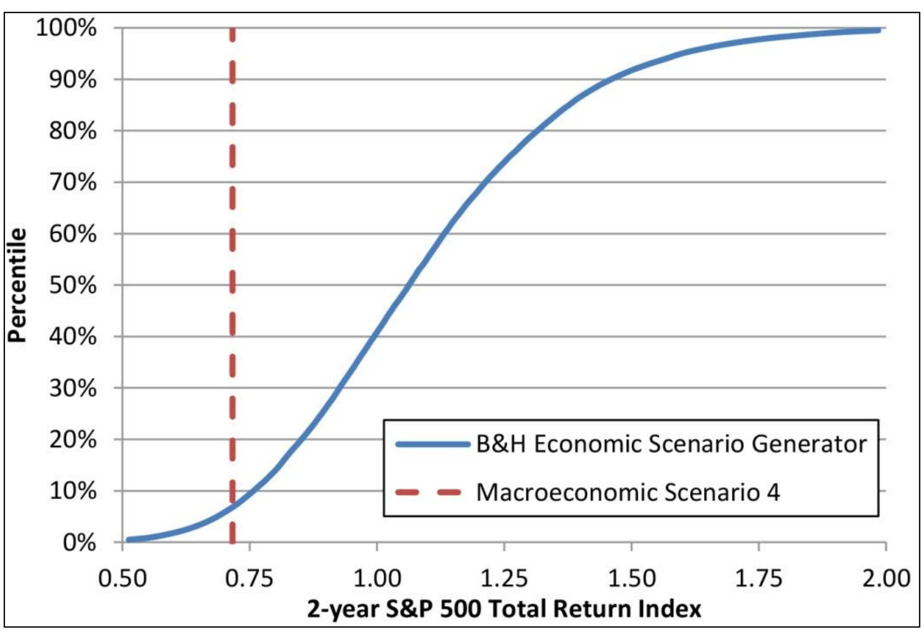


On inspection of exhibits 2 and 3, a typical life insurer may decide that Scenario 4, with its prolonged period of low interest rates and poor short-term equity and corporate bond returns, is likely to be the more challenging scenario for the robustness of its solvency position.

Whilst the overall severity of the economic scenario has been placed at the 96th percentile, it may also be useful to quantify the severity of some of the specific variables that are likely to particularly challenge the firm's risk robustness. For example, on a marginal basis, how severe is the two-year equity return produced in the scenario? Stochastic modelling can provide useful additional and independent quantification into the scenario's probabilistic severity. Exhibit 4 below shows how the 2-year S&P 500 total return produced in Scenario 4 compares with the probability distribution produced by the B&H Economic Scenario Generator (ESG).

Exhibit 4

2-year S&P 500 total return: Scenario 4 and the B&H Economic Scenario Generator



The above chart shows that the 2-year S&P 500 total return produced in the first two years of Scenario 4 sits at around the 6th percentile of the downside tail produced by the B&H Economic Scenario Generator. This can provide some useful additional insight and validation of the severity of specific variables modelled in the stress test. Of course, this process inevitably requires the firm (and perhaps its regulator) to make some quantitative statements about the strength of adversity that should be tested in the ORSA process. Is a scenario around the 5th percentile of the downside tail adverse enough for the purposes of ORSA prospective solvency assessment? The non-prescriptive nature of ORSA means that this is ultimately a matter of judgement, or may perhaps be determined by dialogue between a firm and its regulator.

Finally, it should also be noted that the specific risk exposures and risk management strategies of the firm may place particular demands on the type of macro scenarios that are required in the prospective solvency assessment process. This will naturally impact on the relevant financial and economic variables that need to be projected, but it may also impact on the level of detail of the modelling. For example, if a firm has a risk management strategy that involves weekly re-balancing of a significant delta hedging strategy, its risk robustness will not be well-assessed using annual projection time steps in its multi-year projection. Rather, it will be important to capture the specific risks left behind by its risk management strategy – in this case, it will have exposure to very high volatility in weekly equity returns rather than overall weakness in annual equity performance. This highlights a general important rule in well-functioning principle-based risk assessment: the risk management strategy must drive the risk measurement methodology rather than vice versa.

4. Mapping the macro scenarios onto the firm's risk exposures

Having determined the macro-level stress tests that will be used in the solvency projection, a further step may be required to specify exactly what it means for the firm's risk factors at a more granular level. This may not be a significant task for insurers as their capital modelling tends to model risk factors at an aggregate level and so the macro scenarios may directly describe the change in many of the firm's risk factors. For example, most insurers will model their global equity portfolio exposures using weights to a handful of indices or factors rather than modelling at the individual stock level. However, there are still a number of modelling gaps that may need to be filled in this stage of the projection implementation, such as:

» As mentioned at the end of the previous section, there may be a requirement to transform a quarterly or annual macro stress test specification into a projection of daily or weekly financial market returns. (We'll address the challenges of calculating the capital requirements along the path in the following section).

» A firm may have some highly complex and illiquid asset class exposures that are not captured in the financial market variables modelled at the macro level (e.g. specific forms of significant real estate or credit exposures).

» The assumed behavior of the firm's policyholders (e.g. new business rates and lapse rates) and how they behave jointly with economic variables such as GDP and inflation.

» The behavior of insurance risks such as mortality, longevity and natural catastrophes. Again, the assumed co-dependency between these variables and the economic variables may be critical to the severity of the projection. This will make for challenging modelling assumptions – for example, how much should we expect the S&P 500 to fall by in the event that a global flu pandemic emerges?

A similar risk factor 'mapping' challenge arises in the application of stress testing to banks' balance sheets. Indeed, this can be significantly complex for banks due to the greater granularity with which they model the asset side of their balance sheets. Typically, regression methods are used to determine the expected impact that a given macro variable change has on these more granular risk factors. Whilst a similar approach is theoretically applicable to insurers' balance sheets, it is likely that insurers' will have a smaller pool of empirical data to work with for many of these risks – partly because their risk analysis is looking deep into the tail of long-term horizon events, and partly because the risk exposures are inherently less liquid and observable than those typically found on a bank's balance sheet. So it is likely that expert judgement may need to play a significant role in the specification of the behavior of the insurer's complete set of material risk factors.

5. Calculating capital requirements within stress projections

Firms may be interested in a wide range of financial and business metrics to be produced along the paths of their multi-year stress test projections. However, regulatory guidance inevitably places particular emphasis on the firm demonstrating an understanding of how their capital requirements will behave. For example, the Prospective Solvency Assessment section of the NAIC ORSA Guidance Manual includes the following text:

The insurer should project its future financial position including its projected economic and regulatory capital to assess its ability to meet the regulatory capital requirement.

If a firm were to consider, say, 5 stress tests each with 5 annual steps, capital requirements would need to be re-assessed in 25 different scenarios. As discussed earlier, firms may also have the appetite or need to model many more scenarios (for example, if they are interested in stochastic projections) and/or assess capital requirements more frequently than in annual intervals. Insurers could therefore realistically have an interest in generating many hundreds or even thousands of capital requirements across a wide range of projected circumstances.

The computational demand of such a volume of capital requirement calculations is clearly a function of the complexity of the capital requirement method. For example, for a firm calculating the Solvency II Standard Formula, each capital requirement calculation will require around ten stressed market-consistent liability valuations. For complex liabilities with embedded options and guarantees, each of these valuations will require a full set of risk-neutral economic simulations. A firm calculating C3-Phase II capital in the US on the other hand will 'only' require one set of 'real-world' economic scenarios to calculate the CTE capital number required in its capital requirement methodology. The diagrams below describe these capital modelling projection processes.

Exhibit 5
Calculation of Solvency II Standard Formula Capital Requirement (at **each** time step of each projection scenario)

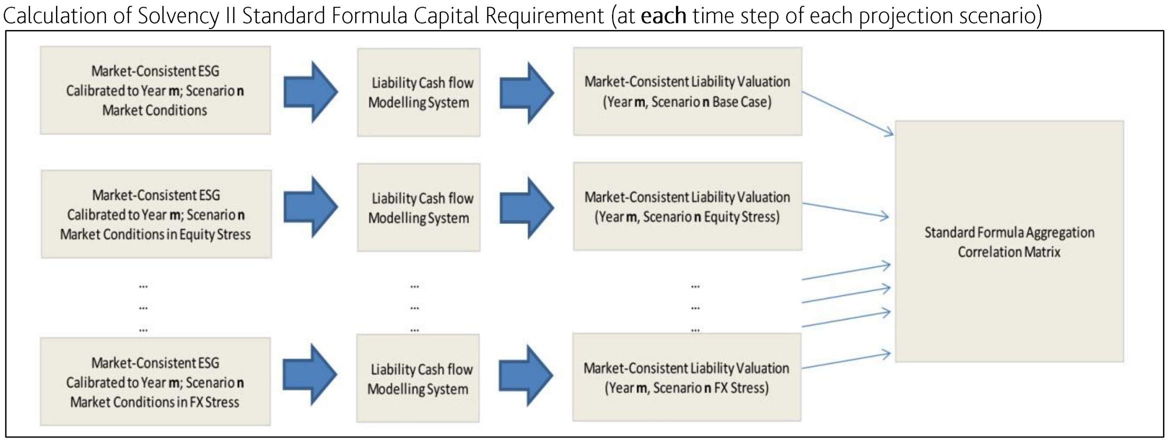
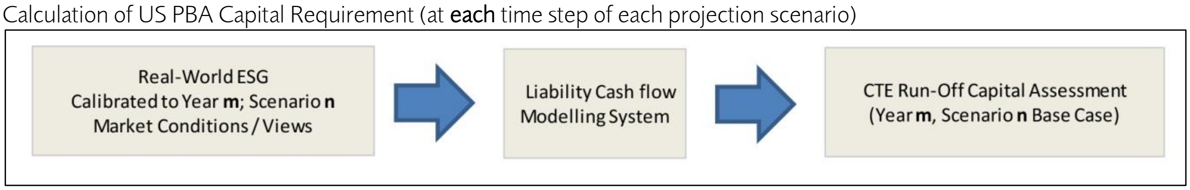


Exhibit 6
Calculation of US PBA Capital Requirement (at **each** time step of each projection scenario)



Note that each of the processes outlined in exhibits 5 and 6 needs to be implemented for *each* of the capital calculations described in exhibit 1.

Solvency II firms may have already implemented a market-consistent scenario calibration and production automation process to support their SCR implementation, so this may 'just' entail extending this automation process to cover the calculation of future capital requirements within the deterministic projections. However, there are two key difficulties that may arise with that approach:

» Clearly the computation and implied run-time requirements are many times greater than the Standard Formula SCR implementation, and this may not be easily supported by existing hardware.

» Firms' asset-liability cash flow models are notoriously unwieldy. Setting these up to calculate the SCR arising in year 5 after a specified 5-year asset return and interest path may be a non-trivial exercise. For a sense of this, we only have to consider how many Internal Model firms are approximating their 1-year VaR modelling by assessing liability sensitivities at time-0 rather than time-1 (because of the challenges of getting the ALM system to output time-1 asset and liability values). More generally, firms' models will also need to allow for new business, net cash flow investment, dynamic asset re-balancing and so on.

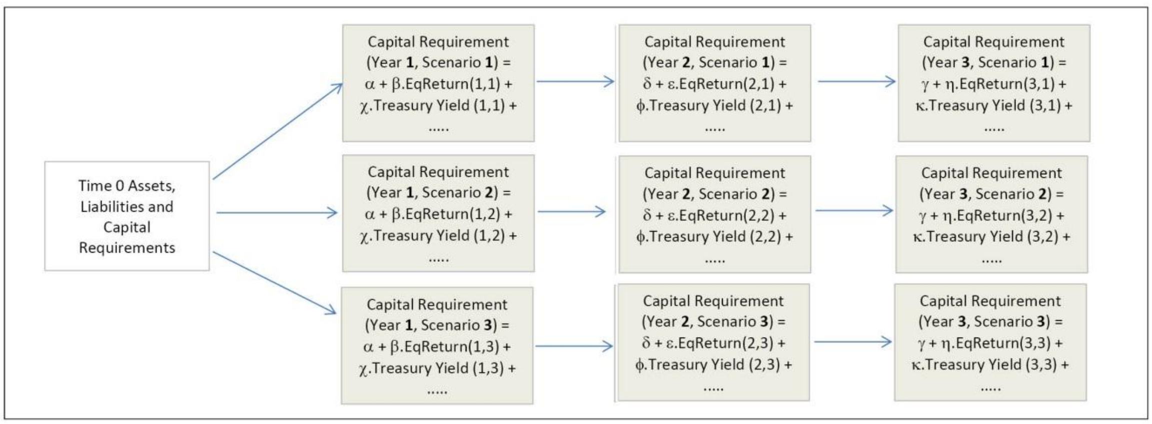
For Solvency II firms intending to calculate the capital requirement produced by their Internal Model SCR methodology, the above complications will remain, but will be compounded by the need to create an algorithmic description of how their IM methodology and its implementation is applied in a wide range of different scenarios.

An analogous set of challenges emerges in the US example described in exhibit 6. It should also be noted that the method for updating the ESG model calibrations between time 0 and future projected points involves an additional layer of subjectivity—the modeller must make a choice about how forward-looking real-world probability distributions are changed by the specified evolution of the risk factor path up to that point.

We expect that these requirements will lead to the implementation of multi-period capital proxy functions that are capable of describing how capital requirements behave over multiple time horizons as a function of the projected paths of relevant risk factors. The process that would then apply is described in the diagram below.

Exhibit 7

Multi-Year Projection of Capital Requirements with Capital Proxy Functions



Developing capital proxy functions that are sufficiently accurate and robust is technically challenging, but we believe that techniques such as Least Squares Monte Carlo provides effective solutions to this demanding computational problem. This topic will be the focus of a further 2013 research report.

6. Conclusions

The topics discussed above highlight that the multi-period capital projection requirements of ORSA need careful consideration by insurance firms' managers and modelers. We believe there are a number of technical insights highlighted in this discussion that should be borne in mind when developing and implementing the OSRA modelling projection framework. Below we provide our top three suggestions:

1. **Firms should use explicit probabilistic measures of the strength of their stress testing**. This is necessary to produce a consistent level of strength across what is likely to be a diverse range of stress tests and risk factors. It will also be important in communicating to senior management what the stresses mean, and in benchmarking the stresses against industry practice.

2. Even with probabilistic targeting, the derivation of macro stresses is still likely to involve economic and risk management expert judgement, and perhaps the use of econometric techniques to extrapolate consistent behavior of other relevant risk factors within the stress scenarios. **Some of the experience in stress testing in the US and EU banking sectors may be useful in developing this part of the modelling framework.** However, there will be insurance-specific aspects to this modelling challenge such as the estimation of policyholder lapse behavior under various forms of macro-economic stress. It is likely that expert actuarial judgement will be required to complement available empirical data in these areas.

3. The computational challenges involved in calculation of regulatory capital assessment within stress projections should not be under-estimated. We anticipate that insurers' unwieldy asset-liability cash flow models will generally find it difficult to meet the increased computational demands of moving from SII Solvency Capital Requirement or US PBA to multi-period ORSA projection. For this reason, we recommend **firms invest in the development of statistically robust multi-period capital proxy functions**. Some firms have explored how statistically powerful techniques such as Least Squares Monte Carlo can be used to meet this challenge, but SII firms in particular have much to do to develop their modelling capabilities from the single (or zero) time-step SCR calculation into a multi-period capital projection capability.

If you would like to discuss any issues raised in this paper, please contact us at: http://www.barrhibb.com/contact